Special Article

Interdisciplinary bodyweight management program for persons with SCI

Amber M. Brochetti[1], Steven W. Brose[1,2,3], Angela M. Kuemmel[1], David J. Dang[1,4], Dennis J. Bourbeau[1,2,5]

[1]Department of Spinal Cord Injury, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio, USA, [2]Cleveland FES Center, Cleveland, Ohio, USA, [3]Syracuse VA Medical Center, Syracuse, New York, USA, [4]Department of Biomedical Engineering, Case Western Reserve University, Cleveland, Ohio, USA, [5]MetroHealth Medical Center, Cleveland, Ohio, USA

Objective: Persons with spinal cord injury (SCI) have a higher prevalence of being overweight than the general population, which is thought to be due to a variety of metabolic, physiologic and psychological changes. The quality improvement project described in this work was designed to help overweight persons with SCI lose bodyweight through nutrition, exercise, and behavioral management strategies.

Methods: Eighteen persons with SCI who were overweight were enrolled in a 12-week interdisciplinary weight management program. Participants were limited to persons at least one-year post-acute SCI with an established overweight status. Measurements, including a person's weight, body mass index, and waist circumference (WaC), were taken at the program's start, at its end, and six months post program.

Results: Seventeen out of 18 participants experienced weight loss, (WaC) decreased ($P < 0.001$), and the program was effective at reducing weight ($P < 0.001$). Six months following participation in the program participants did experience a significant change in weight or waist size six months post program, thus indicating that subjects did not regain weight after completion of the program.

Conclusion: This quality improvement project provided indications of the benefits of an SCI-specific interdisciplinary weight management program. Clinical research evaluating methods for helping persons with SCI achieve a healthy bodyweight is indicated.

Keywords: SCI, Obesity, Weight loss, Interdisciplinary, Nutrition, Exercise, Behavior modification

Introduction

The increasing prevalence of obesity and overweight condition is a medical crisis in the United States.[1–3] Recent studies have shown that approximately 65% of persons who have suffered a spinal cord injury (SCI) are overweight, a rate greater than that of the general population.[1–3] Overweight body habitus has been demonstrated in two studies to have a detrimental effect on the quality of life of persons with SCI.[4,5] One recent study demonstrated that almost a quarter of young persons with paraplegia have sub-par fitness levels, contributing to the obesity that compromises their ability to perform activities of daily living.[6,7]

There are a wide variety of body composition changes that occur after SCI which contribute to the high obesity rate of individuals with SCI. Persons with SCI experience change in neuromuscular activation, leading to muscle atrophy, changes in organ function, and hormonal imbalances.[2] There is also a change in muscle fiber type ratios, leading to a prevalence of Type II muscle fibers in paralyzed muscles and a decline in Type I muscle fibers, which are thought to play a vital role in lipid and glucose metabolism.[8] Resting metabolic rates are lower after SCI, increasing the likelihood for obesity – a person with SCI typically burns 12–54% less calories at rest than an uninjured person.[2] Persons with SCI are prone to secondary medical complications, which may further decrease mobility and independence[9] and decrease caloric expenditure. In the presence of a sedentary lifestyle, cardiovascular changes after SCI may contribute to obesity, glucose intolerance, a reduction of high-density lipoprotein (HDL), an increment of low-density lipoprotein (LDL), and an

Correspondence to: Amber M. Brochetti, Department of Spinal Cord Injury, Louis Stokes Cleveland VA Medical Center, Cleveland, OH, USA. Email: amber.brochetti@va.gov

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elevation of C-Reactive Protein.[10,11] Individuals with SCI are three times more likely than the general population to be diagnosed with diabetes,[12] with approximately a 20% prevalence.[13] The combination of these factors is thought to lead to impaired glucose metabolism, further increasing body fat and risk of obesity.[3]

To combat the rise of obesity in subjects with SCI, medical professionals are well advised to adopt a comprehensive interdisciplinary approach to weight management. Work by Nash *et al.* 2007 demonstrated that many of the cardiovascular disease risk factors present in persons with SCI appear to be reversible with exercise. Increasing HDL levels and decreased serum, total cholesterol and LDL levels,[14–18] as well as improved VO_2, cardiac output and stroke volume[19,20] are among the physiological improvements achieved via exercise. While changes in exercise are vital, so is the need for nutrition education. For a substantial impact in secondary complications of SCI care, a comprehensive plan must also emphasize pairing a nutrition plan with a monitored exercise regimen and behavior modification. Involvement of the interdisciplinary team has been found to have positive effects in improving risk factors for obesity.[21,22]

This quality improvement project provided an interdisciplinary intervention to increase exercise participation and nutritional education competence in order to encourage weight loss in persons with SCI.

The exercise program reflected the guidelines for persons with SCI from the American College of Sports Medicine (ACSM). The ACSM recommends that adults should be exercising about five days a week, with three to five sessions including aerobic or endurance exercises, and two to three doing strengthening exercises. Both types of exercises can be combined in one expanded session, and flexibility exercises can be done daily.[23]

One key aspect of the interdisciplinary approach was utilizing motivational interviewing (MI). MI is a subject centered, directive approach to counseling for behavioral change that emphasizes individual autonomy and a collaborative relationship between subject and provider.[24,25] Hallmarks of MI include the provider eliciting from the subject personally relevant reasons for behavioral change, reinforcing change talk, practicing reflective listening, and perceiving the subject as the expert in behavior change.[26] Research has found MI to be an effective part of a comprehensive interdisciplinary behavioral weight loss intervention.[27] The hallmark components of MI were utilized in the WHEELS program by all disciplines with the focus on behavioral change in nutritional eating; which is where SCI WHEELS participants needed to make the biggest changes. MI techniques were utilized in initial evaluations, follow-up therapy sessions, and group classes.

Methods

This quality improvement project was evaluated by the facility IRB and was determined to be clinical quality improvement as opposed to research, and did not require further review.

A 12-week weight management program specific to overweight individuals with SCI (BMI over 25) was developed. It incorporated an interdisciplinary approach to providing the education tools and resources necessary to assist participants with managing weight. The program was named Working on Healthy Eating, Exercise and Life Style (**WHEELS**). The interdisciplinary team included a registered dietician a physical therapist, a psychologist, and a physician.

Inclusion and exclusion criteria

Participants in WHEELS quality improvement project were limited to persons who were at least one-year post-acute SCI with an established chronic weight issue or obesity diagnosis. Persons were excluded from the program if caloric reduction was prohibited due to wound healing, they were determined to have an active medical concern that would prohibit a change in diet or participation of physical activity, bed rest precautions, cognitive impairment that would limit full participation in the program, or they did not desire to participate.

Overall, twenty-three subjects were offered the program. Eighteen completed it, two declined, and three dropped out before the program ended. The reasons for a subject's declined participation included an unwillingness to change their current diet and physical activity habits after discussion of what the program would entail.

All participants in the WHEELS program were included in the data assessment. Data collection occurred over a period of two years from 2015 to 2017.

Physician evaluation

The program first required clearance from a physician to initiate dietary and physical activity changes. Once cleared, the participant met with a physical therapist to complete a readiness and screening form to assess the participant's likelihood of success. The threshold level for participation was the existence of an established weight issue, such as being defined as overweight by the National Institutes of Health (NIH),[28] or an obesity diagnosis, and a reported desire to lose weight.

Physical therapist evaluation

The screening evaluation entailed a review of the individual's medical history as well as any current or past injuries that may have served as a barrier to physical activity (i.e. upper extremity dysfunction or musculoskeletal dysfunction). The screening also included review of active medications the participant used that may impair exercise response or had side effects of weight gain.

Finally, the physical therapy evaluation utilized an extensive patient interview. A list of questions, as well as a confidence score, were utilized to elicit a subject's readiness and willingness to change current diet, exercise and behavior patterns. Motivational Interviewing was conducted during the screening evaluation to elicit personal relevant reasons for behavioral change, to assess ambivalence, and to collaborate on goal setting for the program. Information collected during this interview was used to determine possible barriers to meeting goals, to identify support systems, and to identify any access limitations such as lack of transportation or geographical location in order to develop individualized weight loss programs.

Physical therapy assessment

After a participant was determined to be appropriate for WHEELS, he or she was scheduled to meet with the physical therapist leading the program. At this meeting, an individualized action plan was developed that best met the participants' needs regarding specific cardiovascular and strength exercise prescription. The physical therapist was also responsible for coordinating with the other team members to form a comprehensive and individualized set of recommendations for the individual subject and ensuring each subject followed through with all recommendations provided. Each professional remained in weekly contact with the physical therapist leading the project to review the progress of the participant. The participant was required to partake in sixty-minute long biweekly group sessions whose content revolved around improving one's knowledge of general nutrition and fitness, tips to make healthy eating choices, weight management strategies, and goal setting. Generalized handouts of the information discussed at the sessions were given to the participants. No post-test was conducted to assess their knowledge retention.

Psychology evaluation

The team psychologist met with all participants to conduct an intake evaluation to assess participant factors that may have contributed to weight gain and/or caused barriers to weight loss. These included: DSM-V diagnoses, psychosocial issues, eating behaviors, and barriers to change. DSM-V diagnoses screened for included commonly seen mood, anxiety, and substance abuse disorders as well as lower prevalence disorders like post-traumatic stress disorder, obsessive compulsive disorder, and eating disorders. Psychosocial issues assessed included family or relationship discord, boredom, loneliness, and feeling bad about oneself. Eating behaviors assessed included difficulty with self-control, devotion to the "clean plate club", "eating too much", and poor food choices or habits. Finally, barriers to change such as frequently eating out at restaurants, dependence on family member or caregiver to prepare food, being accustomed to eating a certain way, and having too much high-calorie food available were also evaluated. The subjects were extensively questioned about their diets as another way to assess eating behaviors. Recommendations for behavior change were given and follow-up sessions conducted as needed.

Dietary evaluation

The dietary evaluation required the recording of a three-day food log consisting of two weekdays and one weekend day that resembled a participant's typical eating pattern. Although there are many acceptable measures for ideal body weight, the dieticians at the Veterans Affairs (VA) Medical Center universally used the Hamwi formula. The Hamwi formula[29] was used to determine an ideal body weight, which was then adjusted for their level of SCI. These adjustments were based on guidelines from the Academy of Nutrition and Dietetics (AND) which stated that there should be a 10–15% ideal weight reduction quadriplegics and a 5–10% reduction for paraplegics.[30]

Following the determination of the ideal weight, the macronutrient ratio approximations were discussed using portion size examples. A person was then educated on their total daily recommended caloric intake as well as their recommended carbohydrate, protein and fat consumption in grams. Subjects were encouraged to eat three meals a day with two snacks. They were issued handouts on portion sizes, a food suggestion list, food preparation recommendations, reading food labels and the use of "My Healthy Plate".

Exercise program

An exercise regimen was developed based on a person's current level of function and modified by severity of SCI (based upon their functional capabilities) with the goal of improving strength and cardiovascular fitness. A circuit resistance training program was used first if level of injury permitted, followed by an individual

resistance training program via therapeutic bands and cardiovascular endurance training via upper extremity cycling. Each program was also individualized based on a person's access barriers (i.e. equipment or transportation availability), time restraints and/or the need for personal support. Expectation for exercise program performance was three to five times a week. Although the exercise regimen was individualized, each participant was expected to expend the same amount of intensity. Intensity levels were measured by the BORG scale.[31] This helped to ensure consistency despite differentiated routines.

If a participant was unable to make scheduled appointments or the group education sessions in person, they were offered to participate via telehealth. This included home to clinic via webcam or telephone visit. This alternative was meant to minimize sessions to help ensure adherence to routine and commitment to the program. All participants met the minimum suggested number of weekly sessions as designed by the program and reflected by the guidelines established by the ACSM.

Measurements

While multiple outcome measurements including the Functional Independence Measure and Quality of Life Questionnaire were obtained, this quality improvement project focused on the following **primary outcome measures**: weight, body mass index, and waist circumference. Secondary outcome measures included diabetes risk score.

Waist circumference was measured by palpating the top of the iliac crests in a supine position and then placing a tape measure slightly above horizontally ensuring it is evenly placed around the waist. The participant was asked to take a breath in and the measurement was taken upon exhalation. Measurements were recorded in inches but have been converted to meters. Waist circumference measurements over 1.02 meters (m) for men and 0.88 m for women are directly associated with an increased risk of cardiovascular disease and diabetes.[32]

The Diabetes Risk Scores (DRS) were also recorded. The DRS is a screening tool that provides a prediction of the risk of developing Type 2 Diabetes.[33] DRS values vary from 0 to 10, with 10 being most at risk. The questions posed by the survey and the resulting score are considered an indicator of the risk of developing a co-morbidity.

Statistical analysis

MATLAB_R2016a was used to conduct the analysis. Quantile-Quantile Plots were used in MATLAB to determine normality. Data were considered approximately normally distributed, with the exception of the Diabetes Risk Scores. Paired t-tests were conducted to compare subject weights as well as waist circumferences for start of program, end of program and 6 months post-program conditions to see if there were significant changes. A Pearson Product Moment Correlation was conducted to see whether starting BMI and age separately correlated with weight loss and change in waist circumference. The Pearson Correlation was also used to see if SCI duration correlated with weight loss as well. A Wilcoxon Signed-Rank Test was used to assess diabetes risk scores to determine if there were significant changes.

Results

Subject demographics

While there were only three drop outs, eighteen participants completed the program. The average age and height of the participants involved were 55.72 (range 23–75) years and 1.78 (range 1.68–1.93) m, respectively. The participants weighed an average of 108.07 (range 77.1–146.2) kilograms (kg) and had an average waist circumference of 1.22 (range 0.9–1.7) m. All participants had SCI for an average duration of 9.11 (range 1–39) years. Data collection was performed at start, program completion, and 6 months post completion of WHEELS program participation (Table 1). Participants 2, 8 and 13 completed the program without dropping out, but did not have 6 month post-program data available for this report. Refer to Table 1 for patient demographics.

Change in weight

By the end of the 12 weeks, seventeen out of the eighteen screened participants experienced a decrease in weight without adverse effects in health. A weight loss of at least 4.5 ± 0.5 kg was considered satisfactory. This was determined by the Center for Disease Control's (CDC) recommendation for healthy weight loss per week.[34] Fifteen out of the eighteen were able to achieve or exceed that benchmark. The three that did not meet their goals failed to hit the fifty percent benchmark of their initially set goal. There were significant differences in the weights for start of program (Mean = 108.07 kg, Standard Deviation = 20.32 kg) and end of program (Mean = 102.46 kg, Standard Deviation = 18.87 kg); $t(17) = 7.82$, (P value < 0.001).

Subject weight was compared at program end and 6 months post-program, andthere were no significant differences in the weights for end of program (Mean = 103.51 kg, Standard Deviation = 16.64 kg) and 6 months post-program (Mean = 102.15 kg, Standard Deviation = 19.23 kg); $t(14) = 0.84$, (P value = 0.41),

Table 1 Subject characteristics at start of program→end of program→6 months post-program.

Subject	SCI Level	Years since injury	Age	Height (m)	Weight (kg)	BMI	WaC (m)	Weight lost (kg)	DRS
1	C3 ASIA A	3	56	1.70	102.33→97.52→79.38	35.33→33.67	1.20→1.19→1.12	4.81	7→6
2	C6 ASIA A	34	60	1.75	80.74→74.84	26.36→24.44	1.1→1.07	5.9	7→5
3	T9 ASIA A	4	43	1.75	105.69→99.34→97.52	34.51→32.44	1.19→1.15→1.15	6.35	5→4
4	C7 ASIA B	39	57	1.83	139.71→129→131.54	41.72→38.52	1.68→1.59→1.59	10.7	8→6
5	C3 ASIA C	2	72	1.85	118.62→113.94→116.12	34.66→33.29	1.31→1.26→1.26	4.67	9→9
6	C3 ASIA C	1	68	1.73	100.93→95.21→96.16	33.72→31.81	1.4→1.35→1.35	5.72	9→9
7	C4 ASIA C	3	65	1.8	129.28→123.61→131.09	39.9→38.15	1.28→1.22→1.27	5.67	8→8
8	C4 ASIA C	2	60	1.68	89.04→82.56	31.55→29.25	1.19→1.17	6.48	8→6
9	C6 ASIA C	12	48	1.93	119.75→119.75→119.75	32.15→32.15	1.23→1.23→1.23	0	6→6
10	C3 ASIA D	12	45	1.85	98.84→92.99→93.44	28.88→27.17	1.12→1.05→1.05	5.9	4→4
11	C6 ASIA D	11	53	1.75	127.01→122.47→116.58	41.47→39.99	1.28→1.27→1.24	4.54	8→7
12	C7 ASIA D	13	58	1.83	92.4→88→92.08	27.59→26.28	1.13→1.11→1.1	4.4	6→6
13	T2 ASIA D	1	62	1.8	146.2→134.17	45.12→41.41	1.35→1.17	12.03	10→9
14	T12 ASIA D	7	37	1.7	118.8→113.85→115.67	41.11→39.39	1.27→1.22→1.22	4.94	5→3
15	T12 ASIA D	5	75	1.75	85.73→84.82→88	27.99→27.7	1.03→1.03→1.03	0.91	7→7
16	L2 ASIA D	5	68	1.73	92.4→88→84.82	30.87→29.4	1.13→1.11→1.09	4.4	8→7
17	MS	7	53	1.78	77.11→73.94→65.77	24.34→23.34	0.95→0.9→0.86	3.18	4→3
18	MS	3	23	1.8	120.66→110.22→104.33	37.24→34.02	1.18→1.12→1.1	10.43	4→3

WaC, waist circumference; MS, multiple sclerosis; DRS, diabetes risk score.

suggesting continued durability of the results. It should be noted that eight participants had regained some weight at this point, but for six of those eight the weight gain did not cause them to exceed their original weight at the beginning of the program. Overall at this six-month mark, about twelve participants had either continued to lose weight or regained only a small portion of the weight they lost.

Waist circumference

By the end of the program, sixteen out of the eighteen persons experienced a decrease in waist circumference. There were also significant differences in the measurements for start of program (Mean = 1.22 m, Standard Deviation = 0.16 m) and end of program (Mean = 1.18 m, Standard Deviation = 0.15 m); $t(17) = 4.5$, (P value < 0.001).

Another analysis was conducted to compare participant waist circumference 6 months post program completion. There were no significant differences in the measurements for end of program (Mean = 1.19 m, Standard Deviation = 0.16 m) and 6 months post-program (Mean = 1.18 m, Standard Deviation = 0.17 m); $t(14) = 1.39$, (P value = 0.19). In addition, when observing the changes in waist circumference, eight participants saw their waist size stay the same compared to their measurement half a year earlier. These results suggest that the participants did not experience a significant gain in weight or change in waist circumference six months after the program ended.

Body mass index

While high BMI scores and patient age are significant factors when determining weight loss potential, these indicators did not factor heavily in this program. Using the Pearson Product Moment Correlation, it was determined that patients with a higher beginning BMI did not lose proportionately more weight than other participants as the relationship between those parameters' P values were less than 0.05. Likewise, a participant's age, as it correlated with weight loss and change in waist circumference, was also considered. A Pearson correlation was conducted and it was determined that there was no relationship between age and those two parameters since the P values were greater than 0.05 (Table 2).

Diabetes risk scores

Finally, when examining Diabetes Risk Scores, eleven out of the eighteen participants experienced improved scores and thus lowered their risk of Type 2 Diabetes. As previously referenced, DRS scores ranged from 0 to 10, with 10 being the most as risk for developing Type 2 Diabetes.[31] At the start of this program, participants' DRS scores ranged from 4 to 10. As the study concluded, the participants' scores decreased, ranging from 3 to 9. It was determined that there was a significant difference in scores before and after the study ($P < 0.001$).

Discussion

Principle findings indicate no significant correlation between age or duration of SCI and weight loss.

Table 2 Correlations and statistical relationships between variables.

	Weight lost	Change in waist circumference
Starting BMI	$r_p = 0.5829$ P = 0.0111*	$r_p = 0.5342$ P = 0.0224*
Age	$r_p = -0.2594$ P = 0.2987	$r_p = -0.0627$ P = 0.8047
Years of SCI	$r_p = 0.1564$ P = 0.5354	

r_p, Pearson's linear correlation coefficient.
*P < 0.05.

Statistical analysis did find a significant change in weight loss and behaviors upon completion of the WHEELS program.

Discussion of findings

Results demonstrated a collective improvement in participants' weight from the start of the program to its conclusion. Overall, at this six-month mark, about twelve participants had either continued to lose weight or regained only a small portion of the weight they lost, and eight participants saw their waist size stay the same compared to their measurement at the end of the program, demonstrating continued durability following the end of WHEELS.

SCI duration, the length of time the patient has had an SCI, did not directly relate to the amount of weight a participant lost (Table 2). This was also observed when comparing SCI level with weight lost. When grouped by descending order of severity, the weight reduction demonstrated by the participants did not exhibit any trend, illustrating that all persons had potential to lose weight, regardless of the level or completeness of their SCI.

Psychology support was helpful in dealing with multiple barriers including psychosocial family support and maladaptive eating behaviors in the setting of this quality improvement project by providing creative coping strategies, offering psychoeducation, reinforcing SMART goals, and behavioral substitution of unwanted habits. Additional interventions focused on expanding food variety by increased food acceptance, mindful eating, and managing craving effectively. These cognitive behavioral and MI-based interventions were crucial to behavioral change.

In addition, patients in this study ranged from higher cervical injuries to lower thoracic injuries and spanned from complete to incomplete injuries (Table 1). Despite the spectrum of participants, the study did not establish a statistical difference between level of injury and amount of weight loss. This may suggest a need for greater emphasis on nutrition over exercise capability in future implementations of this program.

Limitations

Limitations of this quality improvement project include it being a quality improvement program and not a randomized controlled trial. The population was neurologically heterogeneous (i.e. not all subjects had the same ASIA score and level or mechanism of injury). In addition, the VA works more with a chronic SCI population, therefore data regarding pre-SCI BMI was not available on all subjects. According to the 2017 Veteran Population Statistics, the veteran population is comprised mostly of an older population, greater than age sixty and more predominantly male than nonveterans.[35] The sample size was relatively small, and data collection was limited to approximately two years in length. Also, not all individuals had six-month follow-up data available for analysis. Finally, due to time constraints no post-test was given to assess knowledge of retention after group education sessions.

Conclusions

This quality improvement project provided indications of the benefits of a SCI-specific weight management program implemented by an interdisciplinary team. The program was well tolerated without complications or documented adverse effects. Although this project could be strengthened by performing a randomized control study, statistical analysis between groups confirm weight loss by participating in the WHEELS program.

The WHEELS program recognized significant changes in patients' bodyweight and waist circumference, as well as improvements in important measurements like DRS score, through the unique and individualized nature of each participant's plan of action and the use of an interdisciplinary team. By combating the many facets that have contributed to the rise of obesity in the population with SCI, including exercise, nutrition, and mental health, this program was able to establish improvements during the study, as well as, even more importantly, six months following its completion. These conclusions indicate that this program may have clinical benefit for the SCI population.

Disclaimer statements

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Conflicts of interest The authors declare that they have no conflict of interest.

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